

## TO DR. ASA GRAY.

*November 18th, 1810-1885.*

Over the earth is reachless, living light  
In flaming marvels that defy the sight;  
Under the earth are brilliant things, but dead;  
Who toil among them are disquieted.  
The world of green  
That moves between—  
With sweets and colors, flowering turf and height—  
Comes close with health and beauty as with bread,  
Touches us fondly, foot and hand and head,  
Till we are glad and healed as well as fed.  
The child, the feeble, and the lusty man,  
Each finds a mother in the green earth's plan.

Thou who art wise with searching all her looks,  
And givest ages wisdom through thy books;  
The secrets of her breath are in thy hold—  
In years and science only art thou old.

The flowers' faces  
Have sent such graces  
Into thine own, as bless their native nooks.  
Ferns, grasses, ancient trees of mighty mould  
Whose mazy roots run deep, whose aim is bold,  
Their varied forces in thy life have told;  
For, while intent on flower or tree or sod,  
Thy soul's full eye hath been upturned to God.

CHARLOTTE FISKE BATES.

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The Pollen-spore of *Tradescantia Virginica* L.

BY JOHN M. COULTER AND J. N. ROSE.

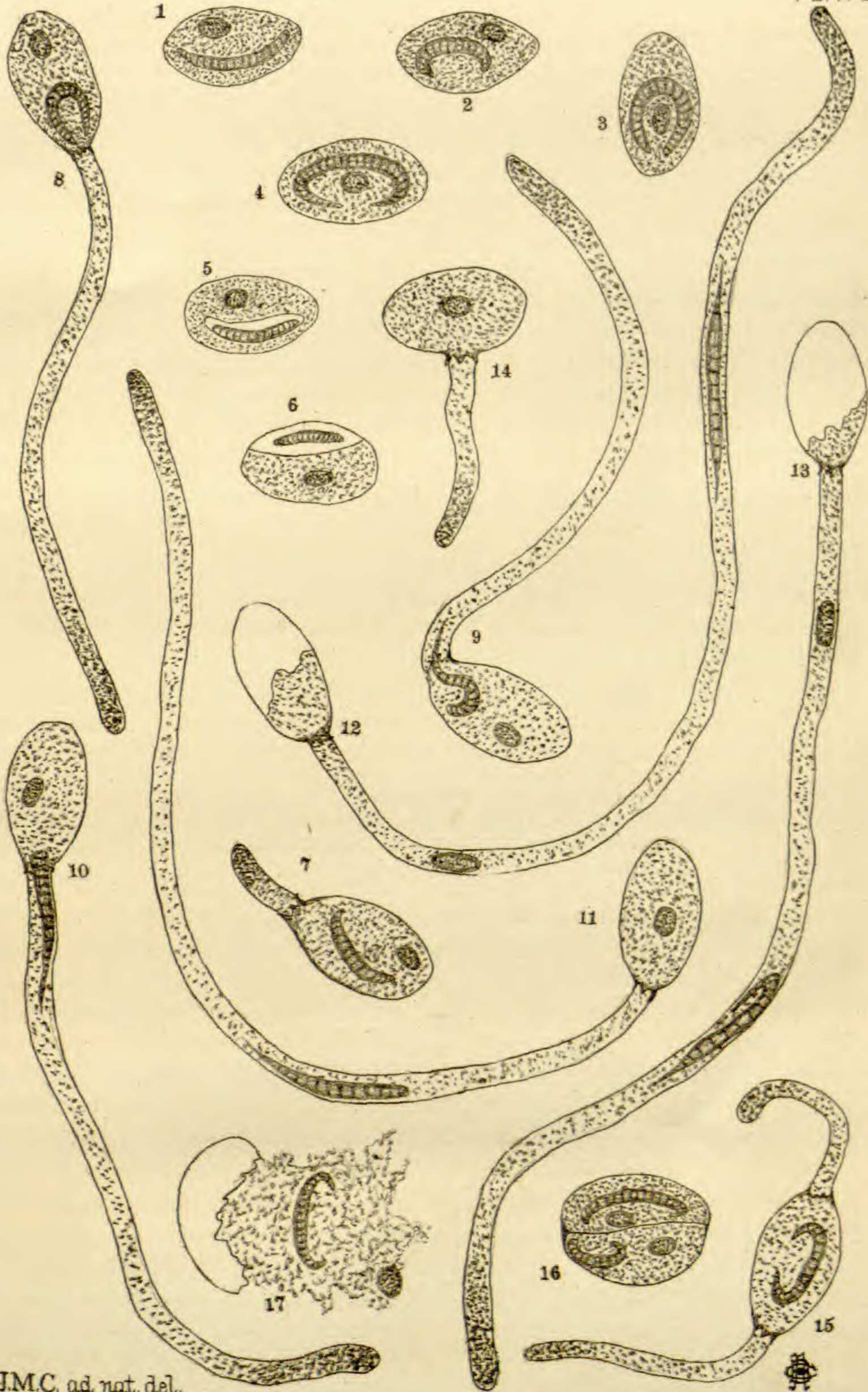
(WITH PLATE I.)

The pollen-spores of *Tradescantia Virginica* are exceptionally favorable for study. With the simplest appliances, and with few staining reagents, both nuclei can be demonstrated, the development of the pollen-tube can be watched, and the descent of the nuclei plainly followed. We have not been able to consult Hartig's paper,<sup>1</sup> in which is recorded the original discovery of two nuclei in pollen-spores, among which he includes those of *Tradescantia*, but the general facts pertaining to the subject are well presented in the works of Strasburger and Sachs, and recently summarized in this country by Goodale. In fact, to Strasburger is due most of our knowledge of this interesting subject, his latest views being presented in the first part of his *Neue Un-*

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<sup>1</sup> Karsten's *Botan. Untersuch.* iii. 1866.





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*tersuchungen*,<sup>2</sup> published in 1884. The only original paper upon the subject published in this country is that of Barnes on *Campanula Americana*.<sup>3</sup>

All these authors agree in their testimony as to the difficulty of performing this work, and so the demonstration of these recondite, but very important, facts has been left entirely to trained investigators. Knowing that the pollen-spores of monocotyledons were much more favorable for study than those of dicotyledons, which are certainly too difficult for ordinary observers, and desiring to discover some plant in which these almost inaccessible facts could be seen with comparative ease, the pollen-spores of *Tradescantia* were selected. The result was so signally successful, and the methods were so repeatedly tested, that we present them in this paper.

The simplest kind of moist chamber was prepared, such as is described by Bower and Vines,<sup>4</sup> and Goodale.<sup>5</sup> Two pieces of heavy blotting paper were cut the size of a glass slide, and a hole cut through the middle of them just large enough to allow a cover-slip to rest upon the edge all around. The slips of blotting paper were then saturated with water and placed upon a glass slide. A saturated solution of cane sugar was prepared, and a drop placed upon a cover-slip upon which pollen-spores had been sown. The cover-slip was then inverted, and placed over the hole cut in the blotters, and the pollen-spores were thus ready to germinate in a hanging drop of sugar solution, in a chamber in which evaporation was impossible. The blotters being kept moistened, the culture was continued as long as desirable. It is always preferable to place the pollen-spores upon the cover-slip before the drop of sugar solution, as otherwise they are apt either to remain out of reach of the objective, or to send their tubes directly towards it, thus giving end views instead of profiles. The best results were obtained with pollen-spores from flowers that had been open for some time, such seeming to respond more readily. A power of 250 diameters was constantly used in the work, though the figures of the plate are drawn larger (460 diameters) for the purpose of securing clearness of detail. The spores are elliptical in optical section, and the extine is so thin and so free from the customary markings of pollen-spores that the details of the interior can be easily seen. In a few min-

<sup>2</sup> For review see Bot. Gazette, x. 328.

<sup>3</sup> Bot. Gazette, x. 349.

<sup>4</sup> Practical Botany, p. 16.

<sup>5</sup> Physiological Botany, p. 430.



utes, at most five or ten, the spores swelled up sufficiently to show their contents, and usually the two nuclei became plainly visible. Figures 1-4 show some of their most common positions. In the nomenclature of these nuclei we use that of Strasburger in his *Neue Untersuchungen*, followed by Barnes in the paper already referred to, and exactly the opposite of that of Strasburger in his *Botanisches Practicum*, and Sachs in his Text-book.<sup>6</sup> The generative nucleus is a thick, worm-like filament, tapering at both ends, and always more or less coiled. Its appearance is exactly that figured by Bernimoulin in his studies<sup>7</sup> in the division of the nucleus in the pollen-spore mother-cells of the same species. The vegetative nucleus is round or oval, of much smaller size, and some of its positions with reference to the generative nucleus are shown in figures 1-4. In some cases, as in figure 4, the generative nucleus is seen almost to encircle the contents of the pollen-spore. In figures 5 and 6 is seen the small cell cut off from the larger one, containing the generative nucleus, and forming the generative cell. The generative nucleus always lies against the intine wall, and its apparent central position in some cases, as in figures 1 and 3, is explained by the fact that it is lying against the upper or lower wall in the figure. The wall which cuts off the generative cell seems to be simply an ectoplasmic layer of protoplasm,<sup>8</sup> and not in any case cellulose. That this layer is often difficult to demonstrate seems to be due both to the fact that the generative nucleus almost entirely fills its cell, and that it is so transparent that only an exceptional position will bring it into view.

Usually within fifteen minutes, or at most half an hour, the pollen-tube can be seen developing from the larger or vegetative cell. It breaks through the extine at one end of the spore, and the broken edges of the extine can be seen turning back from the emerging tube, figure 7. The generative nucleus retains its position until the pollen-tube is of considerable length, when it can be seen shifting its position towards the side of the pollen-spore from which the tube is developing (figure 8). The streaming movement of the protoplasm, which carries the nuclei into the tube, was not demonstrated other than by the changes of position in the nuclei themselves. The fact that the nucleus of the vegetative (large) cell invariably remains towards the further end of the spore until the generative nucleus passes into the tube, seems

<sup>6</sup> Second English edit., p. 554.

<sup>7</sup> Note sur la Division des Noyaux dans le *Tradescantia Virginica*. Bull. Soc. Roy. bot. Belgique, t. xxiii.

<sup>8</sup> Sachs' Text-book, 2d English ed., p. 583.



to be contrary to the usual order.<sup>9</sup> In entering the tube the curved generative nucleus usually straightens, or may remain curved at the posterior end. Its course, as seen, can be traced in figures 9, 10, 11, etc., the coiled posterior end being brought into view in figure 13. Owing to the size of the generative nucleus it was hoped that its division could be demonstrated, but such was not the case. Although in some instances it was suspected, it was not clear enough to be certain.

After the generative nucleus had entered the tube, the nucleus of the vegetative cell seemed to be carried forwards, and when the former had proceeded some distance down the tube, the latter was swept into it, and followed along at considerable interval (figures 10, 11, 12, 13). The vegetative nucleus retained its structure perfectly as far as we were able to trace it in the cultures.

The nuclei in the spores could always be demonstrated after a short immersion in the sugar solution, without the use of a staining fluid, but of course were brought out much more distinctly by it. The nuclei in the pollen-tubes, however, were never seen, with certainty, without staining. The method employed was as follows: A drop each of magenta solution and ordinary acetic acid was placed upon a slide, the cover-slip with hanging drop of sugar solution containing the developing pollen-tubes was let down into it, and then, after a moment or two, glycerine was run under.<sup>10</sup> In this way the nuclei in the tubes receive a dark stain, while the intine is left colorless. Of course there are other and better methods and stains, but our object was to use only such reagents as could be obtained at any drug store. Crushing a stained pollen-spore resulted as shown in figure 17, by which method the shape and structure of the nuclei can easily be studied. It should be said that in many cases both nuclei were not visible, as is represented in figures 14 and 15, although this fact should not be connected with the spores that are exceptional in other respects. In many instances a tube began to develop from each end of the pollen-spore, as shown in figure 15, but one was usually stronger than the other. Quite frequently a pollen-tube developed from one side instead of the end, as represented in figure 14. These two cases would seem to indicate more than one point of emergence, contrary to the general rule among monocotyledons.<sup>11</sup>

<sup>9</sup> Sachs, Text-book, 2d English ed., p. 583; also Strasburger, Neue Untersuchungen, p. 15.

<sup>10</sup> Or the magenta and acetic acid were added directly to the culture drop, allowed to stand a moment, and then inverted and mounted in a drop of glycerine.

<sup>11</sup> Sachs, Text-book, 2d English ed., p. 555.